Communicating Social Presence Through Thermal Hugs

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ABSTRACT
Social Presence is the concept of 'being there', of emotional connectedness to another person. As relationships are increasingly formed by spatially disparate partners, supporting social presence has become more important. As many intimate acts involve touching, this paper investigates the impact that heat, one aspect of touch, has upon social presence. This is presented in the form of a thermal hug. Our findings indicate that there was a significant difference in terms of social presence between those that received thermal 'hugs' and those that did not.

INTRODUCTION
Relationships are one of the things which affect our happiness. People form long lasting relationships which serve a psychological need: when they are successful, they can make us happy; when placed under strain they may fail, with negative consequences for our emotional well-being. Unfortunately we live in a world where people often have to maintain long-distance relationships. This can be a source of relational strain and typically prompts people to try a variety of communication media in an attempt to bridge the distance between one another. Thus, communication media can become surrogates for people to feel close to one another; to repair the damage of separation by maintaining an ongoing sense of emotional connectedness. However abstract symbolic communication technologies are not typically designed for maintaining relationships, they are intended to communicate facts and figures. The majority of such communication systems have been proposed for deployment without consideration for ubiquitous use.

This paper investigates whether a device can be made to support relationships by fostering a special sense of Social Presence – a person's sense of 'being there' with and for someone they care about. In many cultures, touch is an integral component of many relationally intimate acts of communication, such as hand-holding or walking arm-in-arm. We chose to examine the potential of a haptic stimulus for achieving this goal. There has been some work in this area, notably using pressure for hugging [1] and vibration for interpersonal position [2]. However, the haptic devices concerned with intimate communication tend to supplement an existing artefact rather than replicating an action. In this paper, we focus on thermal stimuli as a proxy for the body warmth of the other, delivered in a manner that might suit deployment as a ubiquitous communication technology - as an inconspicuous wearable device.

Togetherness: Synthetic fact or affective state?
Broadly, there are two main ways in which one might conceptualize the problem of how spatially separated people can feel together. The first is to create an environment which is intended to synthesize to some extent representations of people so that they are 'telepresent' to one another. This is the approach taken by those who design and construct virtual worlds, whether for gaming (Second Life or World of Warcraft) or for corporate communication (virtual meeting rooms). They attempt to achieve togetherness by creating a sense of embodied joint location in an artificial space. An alternative approach is to augment each separate person's environment with tokens of the remote other to create a sense of togetherness. These tokens are intended to foster a state of private, emotional connectedness. This is where we situate our work.

Of the prior work that relates to our concerns, investigations of Social Presence best identify the research challenges we want to address. Social Presence has been defined in several ways [3] but the concept originates from the work of Short, Williams and Christie [4]. The baseline concept is "the degree of salience of the other person in the interaction and the consequent salience of the interpersonal relationship" [4]. However, this definition has a significant drawback as it has often been associated with the idea that Social Presence is only determined by the 'richness' of the communication media that connects them. Some of Short et al's work suggested that the type of joint activities people undertake actually works together with the communication technology to govern their sense of closeness. In any case, it is has long been clear that a simple bandwidth model is inadequate to account for a Social Presence. Walther [5] has shown how low-capacity CMC, in the form of email, can generate intense feelings of closeness - a stronger sense of identification with the other than in face-to-face settings. He argues that social cues accumulate over time, as people become attuned to the chronemic properties of this asynchronous technology. Given that we are interested in prolonged separation of people in close personal relationships, this is an important insight. Therefore we treat Social Presence as

the way individuals perceive their discussions, *in terms of* their understanding of the state of their relationship with the other person in the interaction. In other words, where a strong prior relationship already exists, people initially leverage their belief in the health of their relationship with the other as a lens on the mediated message, not the other way around. As a result, a relatively minimal mediated message could be powerful in terms of the relationship, provided it fits in with their understanding of its semiotic appropriateness.

Measuring Social Presense

A major issue for Social Presence research is that there is, as of yet, no accepted method for measuring it [3]. The methodological stance adopted by investigators follows on from the general approach they take to the issue: social presence as a property of the medium or as a phenomenological state of the user. As we have argued, social presence should not be viewed just in terms of the medium and therefore assessment has to be of the CMC system user's feelings towards the other. We chose to use two commonly used social presence questionnaires, Semantic Differentials [6] and Networked Minds [7]. Our device was not of a quality suitable for field testing so it was decided to run an pseudo-experimental study to produce evidence to support the concept of using thermal hugs to support social presence.

The Semantic Differentials (SD) questionnaire is intended to measure a medium's ability to support social presence. It asks study participants to rate the medium in terms of two diametrically opposed adjectives. For example, whether they felt their communication was 'closed' or 'open'. Nine such ratings are made, each on a five point scale to create a profile for the attitudes participants held towards the mediated conversation they held with one another. From our perspective, it is a limitation of this measurement that it asks participants to provide a measure that leads participants to think about the medium more than their experience of one another through the medium. The Networked Minds (NM) questionnaire asks participants to rate their agreement with about 40 statements that relate to social presence, each scored on a Likert Scale. For example, 'My thoughts were clear to my partner' of 'My mood did not affect the other individuals mood'.

The Thermal Hug Belt

Having established our view of social presence, we propose using a 'thermal hug' belt to investigate its impact on social presence. Gooch and Watts, [8], describe the development of the hug belt and concluded that it was safe for use and that it produced perceivable stimuli.

The device consists of a light-weight padded harness (from a backpack), inside which we mounted power, control electronics and, more importantly, three Peltier devices so that they would approximate to the position in which another person's arm would lie if they placed it around the wearer's waist. The Peltier devices, when activated, warm up to create a band of heat around the wearer's lower back. Figure 1 shows the hardware of the device. Although in our experiments it was controlled by a trailing wire, the concept is that it would be worn through the day without the need for a physical connection.

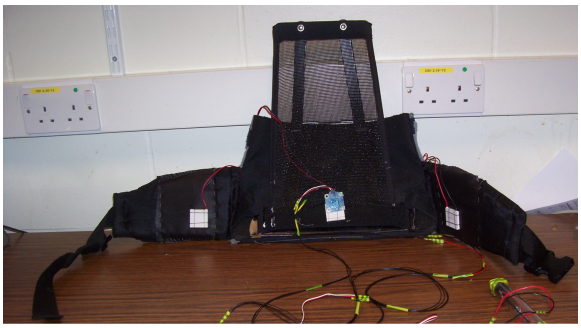

Figure 1. The Thermal Harness

EXPLORATORY STUDY

Having argued that levels of Social Presence are not determined by the communication medium alone, and with some prior evidence that nature of joint activity is instrumental in the Social Presence equation, we want to understand how the task dimension might interact with a minimal haptic stimulus to generate feelings of Social Presence. It was hypothesised that a highly personal task is likely to generate greater feelings of social presence than an impersonal one. It was therefore reasoned that an impersonal task may give greater differences in social presence caused by the thermal stimuli.

Design and participants

We wanted to contrast experiences with and without the belt for each of the two task contexts so we adopted a pseudo-experimental approach, counterbalancing task order across our pairs of participants. Just as tasks could exert an influence on the value of social presence, so could established relationships. It was decided to run the tasks in male/female pairs in either intimate relationships or close friendships. Age and occupation were not a barrier to participation. Our initial investigations have involved only one harness. By selecting male/female heterosexual pairs we expected that gender effects would be controlled, the use of the harness being counter-balanced across male/female participants. Ten mixed-gender pairs of participants completed the study, each having known the other as a good friend (self-rated) for a minimum of a year. All were experienced IM users. This gave us a total of 20 participants who completed the experiment in 10 pairs.

Pairs were made up of a 'heater' (the person providing the heat in some manner) without a harness and a 'heatee' (the person wearing the harness). Our hypothesis was translated firstly into the straight-forward idea that by connecting the thermal stimulus to an action performed by the heater (and that this was known by

both participants) that the effect of the thermal stimuli on the heatee in terms of Social Presence would be increased. Secondly, we anticipated that the more socially positive behaviour of the heatee (assuming the first hypothesis is correct) would reciprocally increase the heater's sense of Social Presence.

The personal task selected was to 'write an account of an holiday or activity you did together'. This was selected as it requires participants to reason and write about one another, highlighting their relationship and possibly fostering a sense of social presence. The impersonal task was the Desert Survival Problem. There was no reason for applying a time limit on either task type as we are not interested in the task performance.

Measures of Social Presence

Having determined the activities that the participants will undertake, it is necessary to consider what effects are expected and conversely how to measure them. Four measures were selected. The first was **Questioning**, participants were asked every 2 minutes to rate "On a scale of 1 to 10 (one being low), how "together" do you feel with your partner?". The second was using a **Rotating switch**, participants were asked to rotate a switch (to control a dial in the software system) dependent on how close they feel to their partner. The third measure was the **Networked Minds Questionnaire (NM) ([7])** which asks 40 questions about the task completed. The final measure was the **Semantic Differentials Questionnaire (SD) ([6])** which asks participants to rank the task and software between opposite adjectives.

Experimental Communication System

Software was necessary to turn the hug belt into an experimental platform to investigate social presence and thermal stimuli. The software had to contain an explicit communication system in order for the experimental tasks to be completed. Instant Messaging (IM) was selected as the base method of communication. It was necessary to design and create a custom system in order to integrate in the task software and thermal harness. The chat program therefore consisted of three parts – a chat section, a task section (either story or desert survival) and a 'loveometer' section. This is a proposed measure of social presence. Each participant was given a rotating switch connected to the dial. They were asked to rotate the switch when they felt a change in connectedness with the other participant.

One of the necessities of the experiment was ensuring that the thermal harness was activated. Without a thermal stimulus being applied, it would not be possible to investigate the effect of heat on levels of social presence. The chat program had a 'hug' button which produced a stimulus. A thermal hug can also be produced from a dial or question rating of 7 or greater. Seven was selected as a strong indicator of social presence as 5 is the 'normal' level. The stimuli were subject to a maximum frequency of 1 every 5 minutes, 2 minutes of stimulus and 3 minutes of cool-down.

Having a 'hug' button integrated into the software to activate the thermal device was intended to create a feeling of connectedness for both partners, the heater for initiating the hug, the heatee from knowing their partner has initiated the hug. The experiment was carried out with the participants physically separated such that other communication media (such as body language) could not be used. Participants had to complete the tasks in silence.

Participants were requested to wear just a T-Shirt, not to experience exercise and to be on campus 30 minutes before the experiment. The reason for this was to ensure that their body had a settled temperature. Likewise the room was air conditioned to a constant temperature. Although body temperatures vary, each participant was in their base state.

RESULTS

The design of the experiment was a two (role, independent) by two (task, repeated) with task order as a control variable. As such, a mixed model MANOVA was selected as the most appropriate statistical test. The loveometer data did not show any significant differences and are not reported here.

Table 1 shows the means and standard deviation from scoring the NM questionnaires from each experimental session. There are 40 questions in the questionnaire giving a maximum possible score of 200. There was a significant difference in the scores of those who received thermal stimuli to those that did not ($F = 6.778$, $p = 0.019$). Those who received the thermal stimuli reported higher levels of social presence. Therefore there is evidence to support the hypothesis that social presence, measured by NM, is higher for heatees than heaters.

Story Task	
Heat (Role)	**No Heat (Role)**
156 (17.9)	150.40 (22.91)
Desert Task	
Heat (Role)	**No Heat (Role)**
158.20 (14.73)	146 (22.21)

Table 1. Mean NM Results (standard deviation in parentheses)

There was also a significant difference with regards to the ordering of the task types ($F = 5.407$, $p = 0.034$). Whichever task was presented first had higher levels of social presence reported. There was no significant difference between the task types or any combination of the factors.

Table 2 shows the means and standard deviation from scoring the SD questionnaires from each experimental session. There are 9 questions giving a maximum score

of 45. There was a significant difference in the interaction between the order of the tasks and the task type ($F = 6.490$, $p = 0.022$). The story task was scored higher when it was completed first. None of the other factors displayed significant differences though heating tended to significance ($F = 3.452$, $p = 0.082$).

Story Task	
Heat (Role)	**No Heat (Role)**
28.50 (4.40)	29.50 (4.33)
Desert Task	
Heat (Role)	**No Heat (Role)**
26.60 (4.06)	30.20 (5.514)

Table 2. Mean SD Result (standard deviation in parentheses)

DISCUSSION

From the experimental results we can state that the overall NM Questionnaire ratings demonstrate that thermal stimuli can give rise to higher perceived levels of Social Presence. No other measure showed a difference with regards to thermal stimuli and social presence though the SD Questionnaire tended to significance. Our reservations with respect to SD as a measurement that focuses on the medium rather than the interaction between people via a medium lead us to see this as a weak measure. We take the position that social presence is impacted by the medium, the task type and the relationship of the participants. However, the *near* significance of the SD results suggest that we should persist with its use in our further investigations or risk a Type 2 error. The NM Questionnaire results demonstrated that there a task effect of the type we anticipated - Social Presence is more meaningful for personally involving tasks rather than depersonalized transaction-type tasks - but only by interaction: the story task scored higher only when completed first, whereas the desert survival NM scores were not significantly different whether completed first or second.

The SD Questionnaire demonstrated that the story task was rated significantly higher when completed first. One explanation for this could be that the tasks did not lend themselves to direct comparison. To investigate this further we propose that a further study be undertaken to compare more similar tasks – for example, compare the Desert Survival task against a task whereby participants have to rank potential date locations.

CONCLUSION

The main implication of our ongoing investigation is that thermal hugs create higher feelings of social presence between participants. Whether this is due to the thermal stimuli or the implicit meaning carried over from mimicry existing behaviour (i.e. hugs) warrants further investigation. We have just begun to consider the importance of device conspicuity. Our design context is for highly personal communications and we carry with that concept the idea that such communications are underpinned by privacy. However, the personal gestures we referred to at the beginning of the paper - walking hand-in-hand or arm-in-arm - are public. Thus there is room to explore through our future work the boundaries of the personal in public.

This paper has determined that the two questionnaires, NM [7] and SD [6] can be used in experimental sessions. The importance of this is that given the lack of evaluation undertaken by most work in this area, there is no reason why the questionnaires shouldn't be used. However we regard the role of these questionnaires in the methodological approach to highly personal Social Presence as an important open issue, including the possibility of questionnaire fatigue from NM and the continued lack of reliability and validity testing.

We believe that it is necessary is to create a usable theoretical framework of the factors that can affect Social Presence in this context, capable of informing both design and evaluation activities, in order to gain a deeper understanding of the concept which, as this paper has highlighted, is currently under specified.

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